3.0 THE EPA GROUND-WATER CLASSIFICATION SYSTEM

The EPA Ground-Water Protection Strategy established three general classes of ground water representing a hierarchy of ground-water resource values to society. These classes are:

- Class I - Special ground water
- Class II - Ground water currently and potentially a source for drinking water
- Class III - Ground water not a source of drinking water.

The classification system is, in general, based on drinking water as the highest beneficial use of the resource. Ground water does serve other beneficial uses, such as manufacturing, electric power generation, livestock production, irrigation, and ecosystem support. Most such uses of ground water will be encompassed in Class I or Class II, in that water of a quality suitable for drinking will also be of a quality to serve as a raw water source for most other beneficial uses. Class I does include a special non-drinking-water component for "ecologically vital" ground water. A more complete discussion of the other beneficial uses of ground water is found in Appendix B.

The classification system is designed to be used in conjunction with the site-by-site assessments typically conducted by the EPA program offices in issuing permits, deciding on appropriate corrective action, etc. The Agency does not have authority within its statutes to require states to do broad-scale, in-advance (anticipatory) aquifer mapping or classification. Those states which do choose to adopt such tools will, of course, have a key component for comprehensive resource management. Anticipatory classification of aquifers is one of the ten components of a state comprehensive ground-water protection program recommended by the National Ground-Water Policy Form (Conservation Foundation, 1985).

The EPA Ground-Water Classification system allows EPA to incorporate many of the same concepts found in state systems into the Agency's routine case-by-case decision making. An important surrogate for in-advance mapping employed in the EPA system is the Classification Review Area. This is the area or, in actual terms, the volume to which the classification criteria primarily apply and is explained more thoroughly in Section 3.2.

The remaining discussion in this section focuses on defining the classes and key terms and concepts of the EPA Ground-Water Classification System. Many technical terms are used in the descriptions, a number of which are defined in the Glossary (Appendix A).

The class definitions presented in this document have evolved from those presented in the Ground-Water Protection Strategy. While there are no substantive changes in the class concepts, the descriptions are revised to reflect the results of the guidelines development process. For this reason, the reader should reference those parts of the Strategy document defining the classification system primarily for background purposes.

Finally, it should be noted that the Agency is requesting public comment on all these terms and definitions. Particular attention should be placed on the approach to defining three Class I terms: "highly vulnerable," "substantial population," and "economically infeasible." Whereas only one option is presented for the bulk of the classification terms, two options are presented for each of these three Class I defining terms.

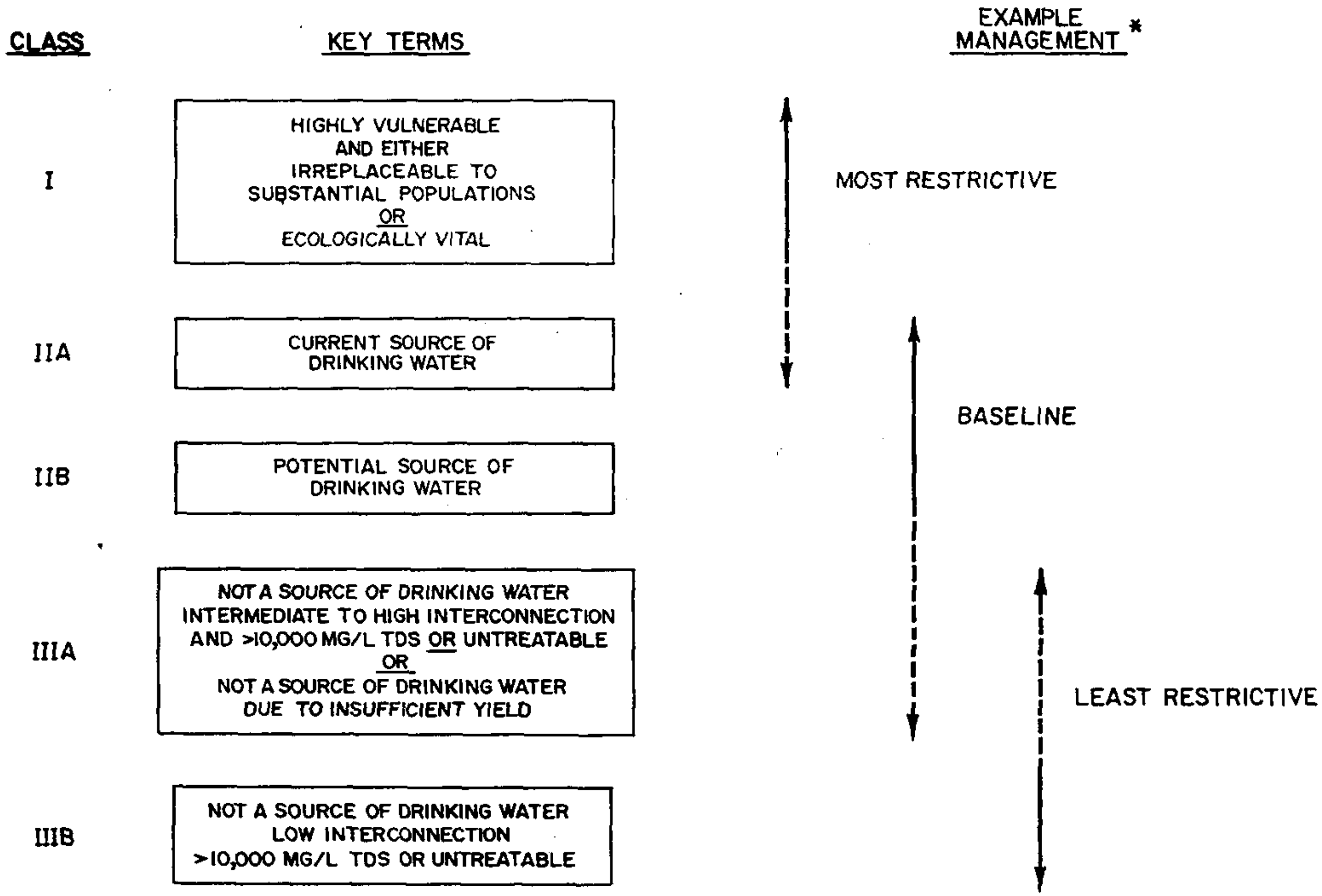
3.1 An Overview of the Ground-Water Classes and Subclasses

The EPA Ground-Water Classification System consists of three major classes. Two classes are subdivided into subclasses, allowing for the refinement in the hierarchy of recognized resource values (Figure 3-1). The classes and subclasses of ground water are differentiated using key terms and concepts. The relationship between classes and key terms is illustrated in Figure 3-2 and flow-charted conceptually in Figure 3-3.

3.1.1 Class I - Special Ground Waters

Class I ground waters are resources of unusually high value. They are highly vulnerable to contamination and are (1) irreplaceable sources of drinking water and/or (2) ecologically vital. Ground water may be considered "irreplaceable" if it serves a substantial population, and, if delivery of comparable quality and quantity of water from alternative sources in the area would be economically infeasible or precluded by institutional constraints. (It should be noted that the Agency is providing several options for determining these factors, so as to focus public comment on the best way of incorporating these concerns in classification decisions.) Ground water may be considered "ecologic-

FIGURE 3-1
SUMMARY OF GROUND-WATER CLASSES



* *Management approaches will be developed on a program-specific basis in EPA.*

FIGURE 3-2
RELATIONSHIP OF CLASSES, KEY TERMS, AND CONCEPTS

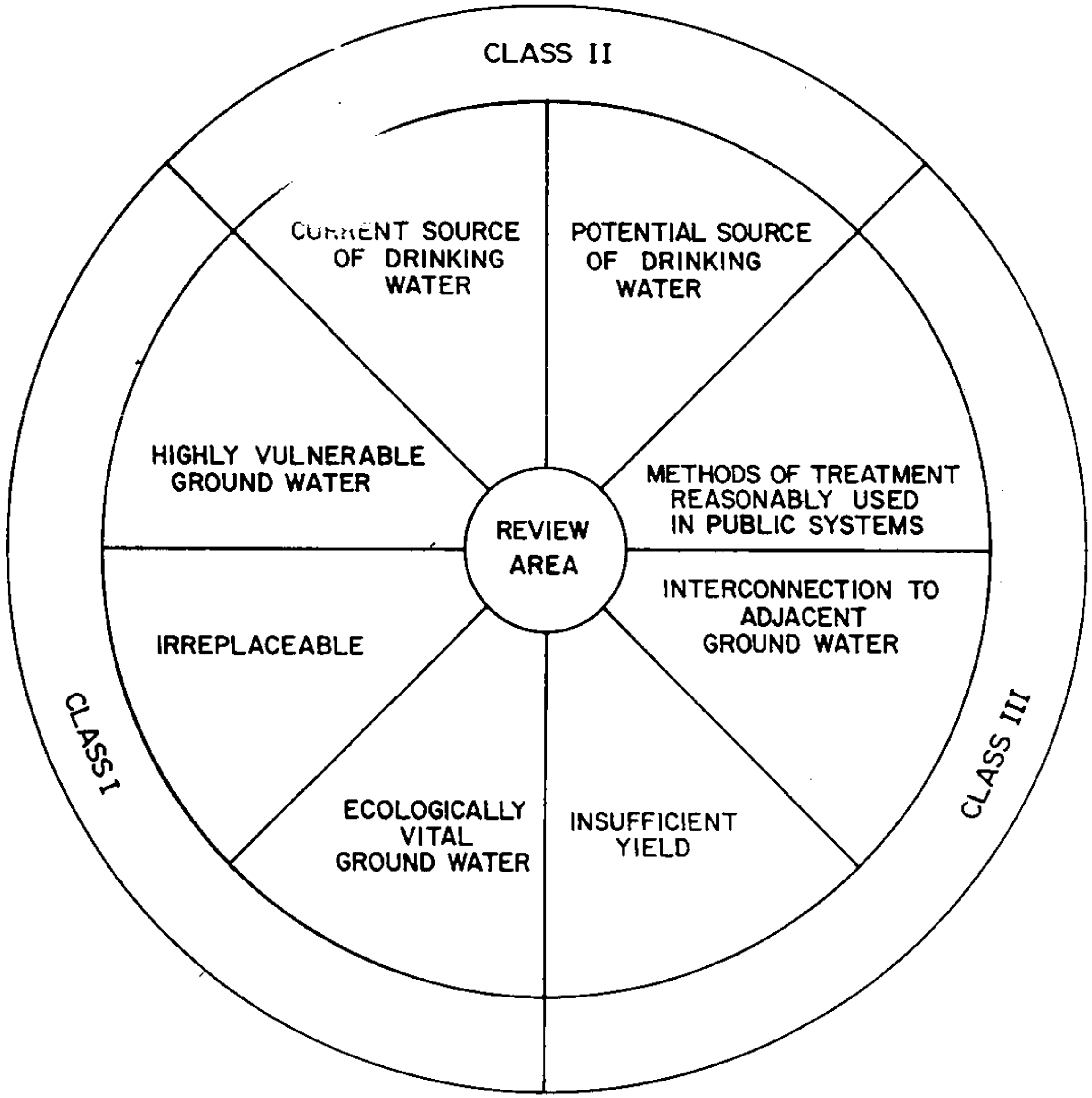
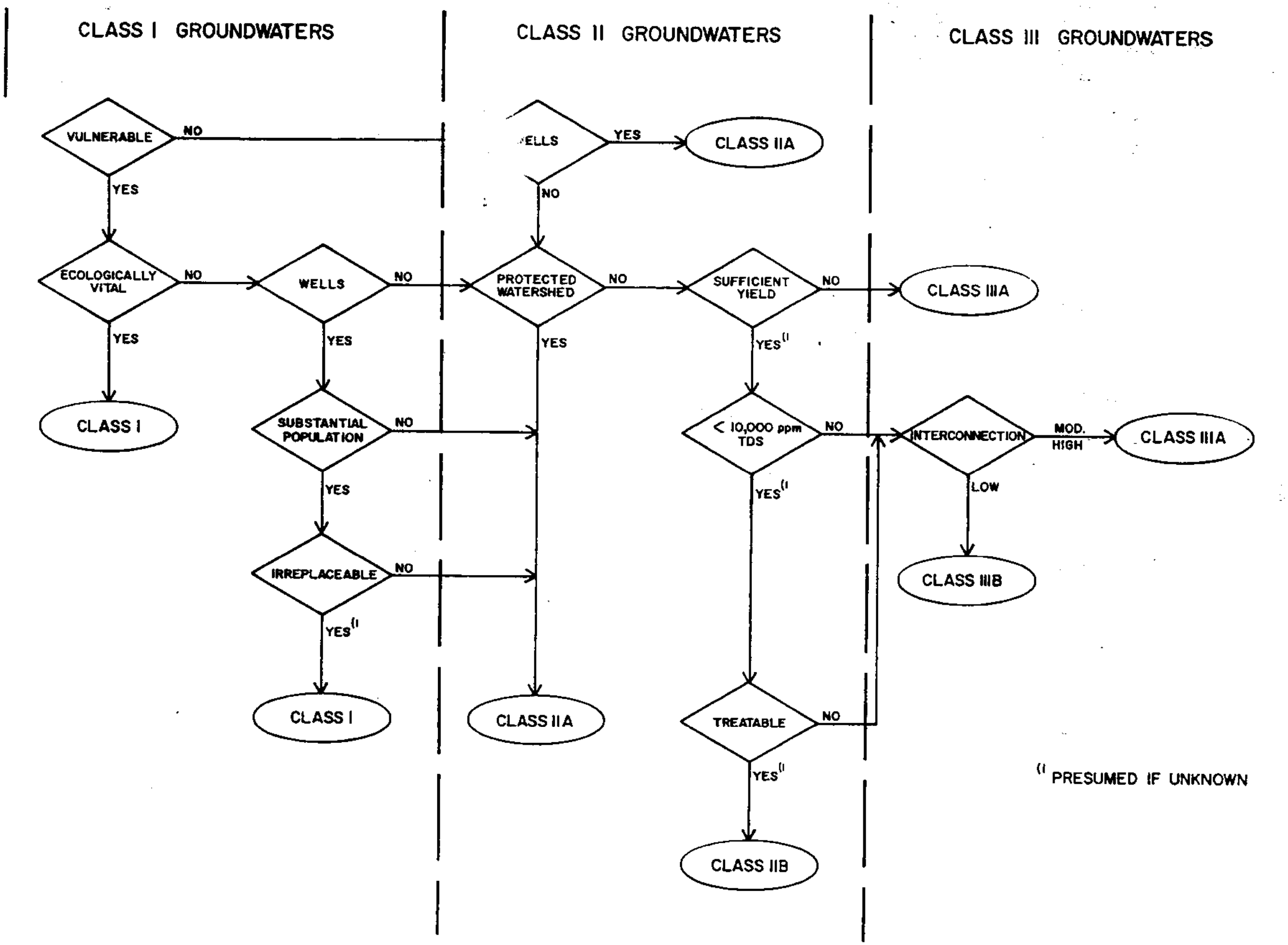


FIGURE 3-3
CONCEPTUAL CLASSIFICATION FLOW CHART



ally vital" if it supplies a sensitive ecological system that supports a unique habitat.

It should be noted that a site located in a designated Safe Drinking Water Act Sole Source Aquifer (SSA) is not automatically placed in Class I. The criteria for SSAs are less rigorous than those of Class I. Greater rigor is needed for classification since, unlike SSAs, Class I will be a decision-making factor in program regulations. SSAs are only considered at the Federal level under financially assisted projects such as farm loans, rural water districts, etc.

It is expected that Class I decisions will be small in number. Such ground waters will generally receive <u>extraordinary</u> protection due to the potential risk to large numbers of citizens dependent upon a source of drinking water or the risk of further endangerment to endangered or threatened species dependent upon unique habitats.

The key terms and concepts used to distinguish Class I include:

- highly vulnerable to contamination
- ecologically vital ground water
- irreplaceable source of drinking water
  - substantial population
  - comparable quality
  - comparable quantity
  - institutional constraints
  - economic infeasibility.

3.1.2 <u>Class II - Current and Potential Sources of Drinking Water and Water Having Other Beneficial Uses</u>

All non-Class I ground water currently used, or potentially available, for drinking water and other beneficial use is included in Class II, whether or not it is particularly vulnerable to contamination. This class is divided into two subclasses; current sources of drinking water (Subclass IIA), and potential sources of drinking water (Subclass IIB).

Class II ground waters comprise the majority of the nation's ground-water resources that may be affected by human activity. Class II ground waters will generally receive the very high level of protection which represents the "baseline" of EPA programs. It is assumed that any ground water which is currently used for drinking water will fall in Subclass IIA, unless Class I criteria apply. Other ground waters are considered potentially usable as a source of drinking water, both from quality and yield standpoints (Subclass IIB), until demonstrated otherwise.

3.1.3 Class III - Ground Water Not a Potential Source of Drinking Water and of Limited Beneficial Use

Ground waters that are saline, or otherwise contaminated beyond levels which would allow use for drinking or other beneficial purposes, are in this class. They include ground waters (1) with a total dissolved solids (TDS) concentration over 10,000 mg/l, or (2) that are so contaminated by naturally occurring conditions, or by the effects of broad-scale human activity (i.e., unrelated to a specific activity), that they cannot be cleaned up using treatment methods reasonably employed in public water-supply systems.

Class III ground-water units* are subcategorized primarily on the basis of their degree of interconnection with surface waters or adjacent ground-water units of a higher class. In addition, Class III encompasses ground waters in those very rare settings where yields are insufficient from any depth within the Classification Review Area to meet the needs of an average size family. Such ground waters, therefore, are not potential sources of drinking water.

The key terms and concepts used to evaluate a Class III decision include:

- interconnection to adjacent ground-water units (as defined in Section 3.3) and surface waters
- treatment methods reasonably employed in public water supply systems
- insufficient yield.

Subclass IIIA includes ground-water units which are highly to intermediately interconnected to adjacent ground-water units of a higher class and/or surface waters. These may, as a result, be contributing to the degradation of the adjacent waters. They may be managed at a similar level as Class II ground waters depending upon the potential for producing adverse effects on the quality of adjacent waters.

The subdivision of Class III represents a refinement in the classification system as originally presented in the Ground-Water Protection Strategy. Placing shallower, more interconnected, ground waters in Class II, for example, would

*The concept of ground-water units is discussed in Section 3.3.

imply a quality and resource value that may not be appropriate. The Class IIIA designation in these cases provides a clear indication that these highly interconnected ground waters are not in themselves sources of drinking water.

Class IIIB is restricted to ground-units characterized by a low degree of interconnection to adjacent surface-waters or other ground-water units of a higher class within the Classification Review Area. These ground waters are naturally isolated from sources of drinking water in such a way that there is little potential for producing adverse effects on quality. They have low resource values outside of mining or waste disposal.

3.2 Classification Review Area

Classifying ground water necessitates delineating a segment of ground water to which the classification criteria apply. Since EPA is not classifying ground water on a regional or aquifer-specific basis, an alternative to defined aquifer segments is needed. This is the Classification Review Area.

It is important to understand that the Classification Review Area is delineated as part of the site-by-site review process. It is a review area and not a regulatory area. To put it another way, EPA believes it appropriate to look at a broad area for characterizing the types of ground water of concern. Regulatory or permit controls will not be imposed in that entire area; only that particular portion or site which is subject to the EPA program which is utilizing the classification for decision making.

The Classification Review Area is delineated based initially on a two-mile radius from the boundaries of the "facility" or the "activity." The facility or activity may be physical in nature (e.g., the edge of proposed surface impoundment) or hydrogeologic (e.g., the edge of contamination area). The dimensions of the Classification Review Area can be expanded in hydrogeologic settings of intermediate to very high ground-water flow velocities where these velocities occur over distances greater than two miles. A detailed discussion of these settings and procedures to expand the review are provided in Part II, Section 4.2.

Within the Classification Review Area, a preliminary inventory of public supply wells, populated areas not served by public supply, wetlands, and surface waters, is performed as described in Part II, Section 4.1. The classification criteria are then applied to the Classification Review Area and a classification determination made.

Initially, all ground water within the Classification Review Area is assumed to be highly connected hydrogeologically to the activity (both vertically and horizontally). This approach will always lead to the highest class determination. Where more hydrogeologic data are available, the Classification Review Area can be subdivided to reflect a more accurate appraisal of the interconnection between the ground waters associated with the activity and other ground waters of the Classification Review Area. This topic is presented in the following section (3.3). Where the Classification Review Area is subdivided, a decision resulting in several ground-water classes could result. For example, a disposal well could potentially affect all ground water through which the well is constructed. If the disposal well penetrates a fresh water zone in order to inject into a deeper, salt water zone, a classification decision for both zones would be needed.

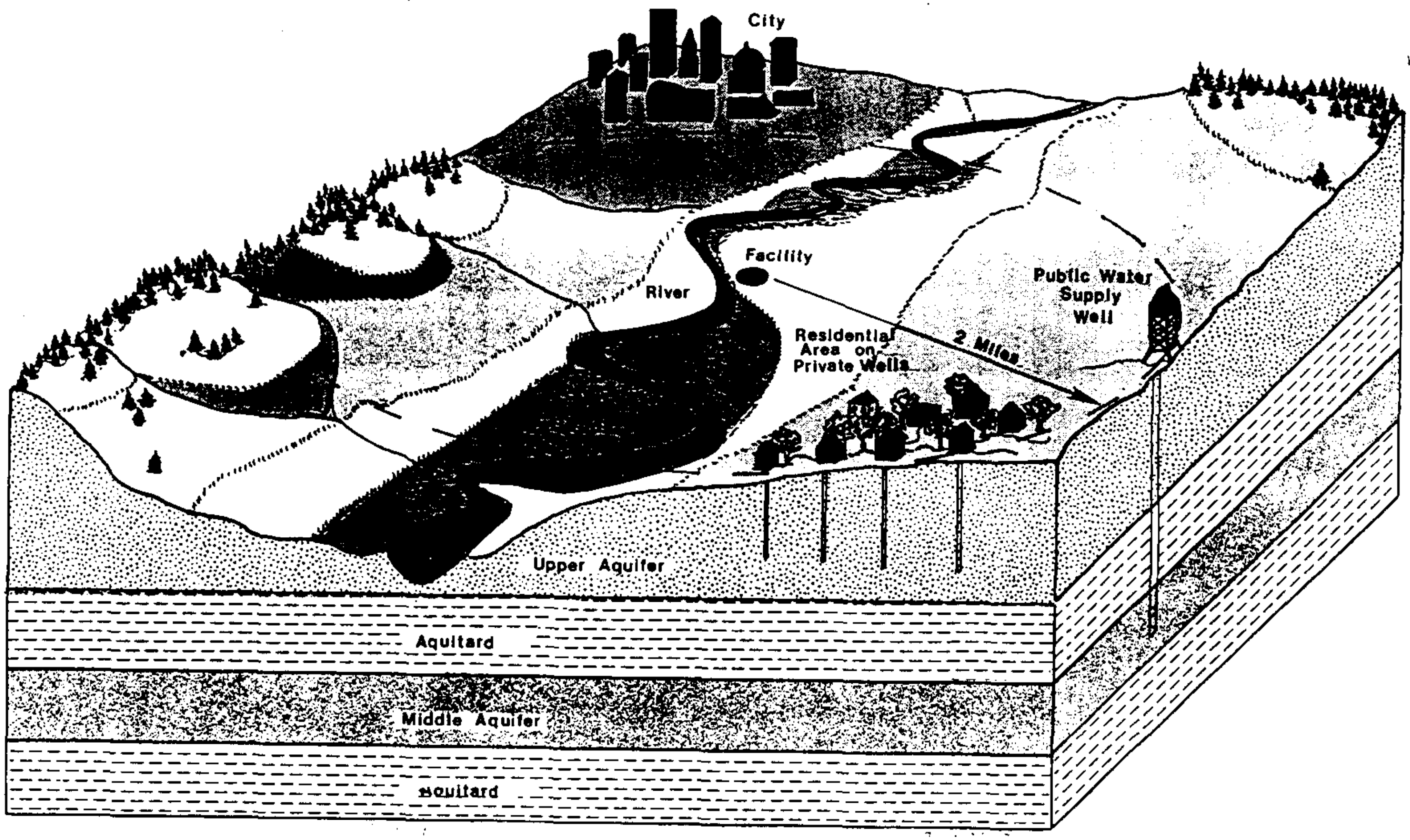
Figure 3-4 illustrates a Classification Review Area around a proposed facility. The site of the facility is approximately 500 feet in diameter. Water supplies in the Classification Review Area include a public water supply system well and a densely settled area of private wells. A river with a wetland runs through the review area. Each of these facts may bear on the decision of the class of ground water.

3.2.1 Technical Basis for Two-Mile Radius

EPA examined three sources of data in establishing the radius of the Classification Review Area. The data provided insight into the length of flow path over which high degrees of interconnection occur. In addition, they indicate distances contaminants could be expected to move in problem concentrations should they be accidentally introduced into the ground-water system. The data sources were:

- A survey of contaminant plumes from investigations of existing spills, leaks, and discharges
- A survey of the distances to downgradient surface waters from hazardous-waste facilities
- Calculations of the distances from which pumping wells draw ground water under different hydrogeologic settings.

FIGURE 3-4
HYPOTHETICAL CLASSIFICATION REVIEW AREA SHOWING POTENTIAL CLASS DETERMINING FACTORS



A discussion of this data and its interpretation is provided in Appendix E.

3.3 Subdivision of the Classification Review Area: Concepts of Ground-Water Units and Interconnection

Subdivision of the Classification Review Area is allowed in order to recognize naturally occurring ground-water bodies that may have significantly different use and value. For purposes of subdividing the review area, these ground-water bodies, referred to as "ground-water units", must be characterized by a degree of interconnection (between adjacent ground-water units) such that an adverse change in water quality to one ground-water unit will have little likelihood of causing an adverse change in water quality in the adjacent ground-water unit. Each ground-water unit can be treated as a separate subdivision of the Classification Review Area. A classification decision is made only for the ground-water unit or units potentially impacted by the activity.

The concepts of ground-water units and the interconnection between adjacent ground-water units are particularly important to the application of the classification system. First, the degree of interconnection to adjacent ground-water units and surface waters is a criterion for differentiating between subclasses of Class III ground waters. Second, the delineation of ground-water units establishes a spatial limit for classification and the application of protective management practices. Hydrogeologists routinely assess the interconnection between bodies of ground water for such purposes as designing water-supply systems, monitoring systems, and corrective actions of contaminated water. Where ground-water bodies are shown to be poorly interconnected, it is possible to spatially distinguish between their use and value. Waters within a ground-water unit are inferred to be highly interconnected and, therefore, a common use and value can be determined. As a consequence, it is possible to selectively assign levels of protection to specific ground-water units to reflect differences in use and value. Protection applied to adjacent ground-water units will have little beneficial effects.

The identification of ground-water units and the evaluation of interconnection between ground-water units may, in critical cases, require a rigorous hydrogeologic analysis. The analysis may be dependent upon data collected off site that is not part of the readily available information normally used in a classification decision. For these reasons, the acceptance of subdivisions will be on a case-by-case basis after review of the supporting analysis. A discussion of appropriate analyses is presented in Part II, Chapter 4.0.

3.3.1 Ground-Water Units

Ground-water units are components of the ground-water regime, which is defined as the sum total of all ground water and surrounding geologic media (e.g., sediment and rocks). The top of the ground-water regime would be the water table; while, the bottom would be the base of significant ground-water circulation. Temporarily perched water tables within the vadose zone (see Glossary) would generally not qualify as the upper boundary of the regime. The Agency recognizes that upper and lower boundaries are sometimes difficult to define and must be based on the best available information and professional judgment.

The ground-water regime can be subdivided into mappable, three-dimensional, ground-water units. These are defined as bodies of ground water that are delineated on the basis of three types of boundaries as described below:

Type 1: Permanent ground-water flow divides. These flow divides should be stable under all reasonably foreseeable conditions, including planned manipulation of the ground-water regime.

Type 2: Extensive, low-permeability (non-aquifer) geologic units (e.g., thick, laterally extensive confining beds), especially where characterized by favorable hydraulic head relationships across them (i.e., the direction and magnitude of flow through the low-permeability unit). The most favorable hydraulic head relationship is where flow is toward the ground-water unit to be classified and the magnitude of the head difference (hydraulic gradient) is sufficient to maintain this direction of flow under all foreseeable conditions. The integrity of the low-permeability unit should not be interrupted by improperly constructed or abandoned wells, extensive, interconnected fractures, mine tunnels, or other apertures.

Type 3: Permanent fresh water-saline water contacts (saline waters being defined as those waters with greater than 10,000 mg/l of Total Dissolved Solids). These contacts should be stable under all reasonably foreseeable conditions, including planned manipulation of the ground-water system.

3.3.2 Interconnection

The type of boundary separating ground-water units reflects the degree of interconnection between those units. Adjacent ground-water units demarcated on the basis of boundary Type 2 are considered to have a low degree of interconnection. A low degree of interconnection implies a low potential for adverse changes in water quality within a ground-water unit due to migration of contaminated waters from an adjacent ground-water unit. A low degree of interconnection is expected to be permanent, unless improper management causes the low-permeability flow boundary to be breached. The lowest degree of interconnection occurs where a Type 2 boundary separates naturally saline waters from overlying fresh waters (less than 10,000 mg/l TDS), and the hydraulic gradient (flow direction) across the boundary is toward the saline waters.

Adjacent ground-water units demarcated on the basis of boundary Type 1 and 3 are considered to have an intermediate degree of interconnection. An intermediate degree of interconnection also implies a relatively low potential for adverse changes in water quality within a ground-water unit due to migration of contaminated waters from an adjacent ground-water unit. Type 3 boundaries, however, are characterized by a diffusion zone of fresh water-saline water mixing that will be affected by changes in water quality in either of the adjacent ground-water units. Type 2 and 3 boundaries are also prone to alteration/modification due to changes in ground-water withdrawals and recharge.

A high degree of interconnection is inferred when the conditions for a lower degree of interconnection are not demonstrated. High interconnection of waters is assumed to occur within a given ground-water unit and where ground water discharges into adjacent surface waters. A high degree of interconnection implies a significant potential for cross-contamination of waters if a component part of these settings becomes polluted.

3.3.3 Illustration of a Subdivision

The Classification Review Area depicted previously in Figure 3-4 may be subdivided based on hydrogeologic considerations to narrow the focus of the classification decision to the ground-water unit most relevant to the facility. For example, the hydrogeology may consist of two aquifers sep-

FIGURE 3-5
ILLUSTRATION OF A HYPOTHETICAL CLASSIFICATION REVIEW AREA

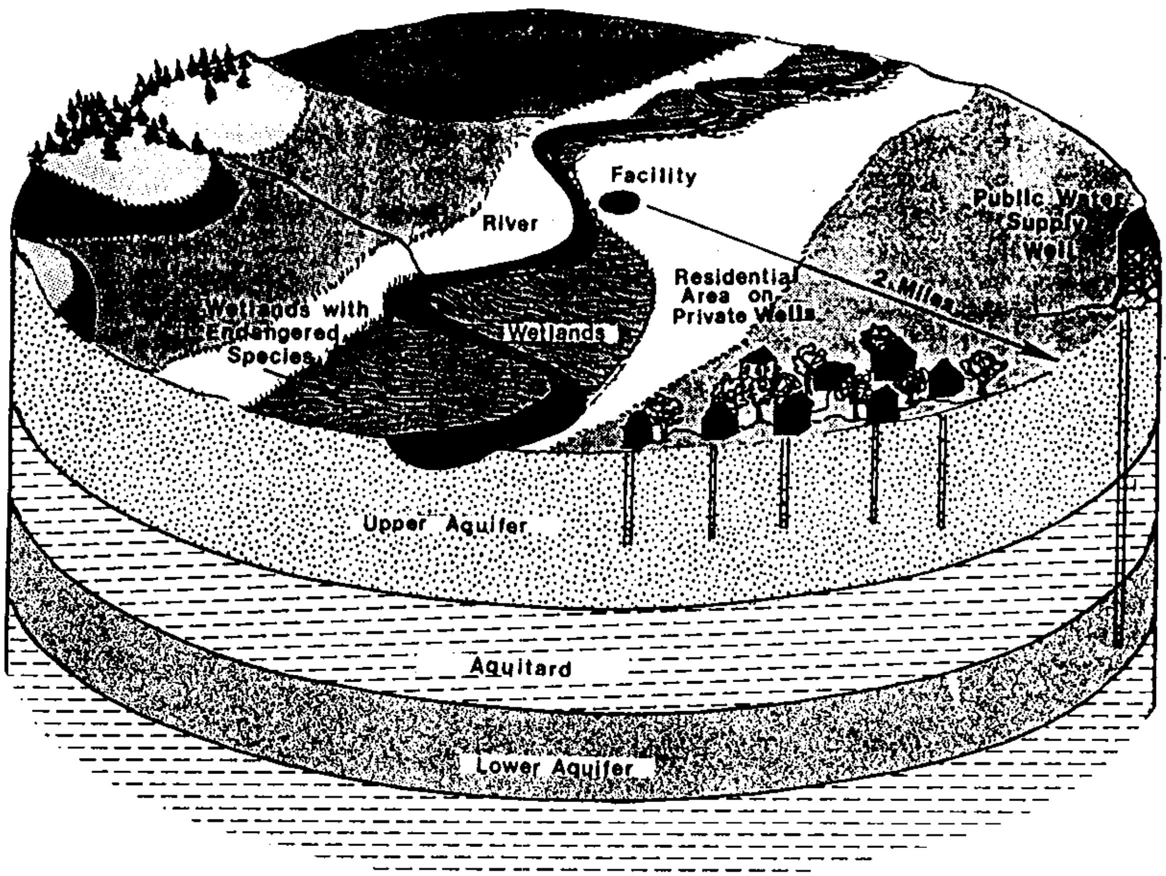
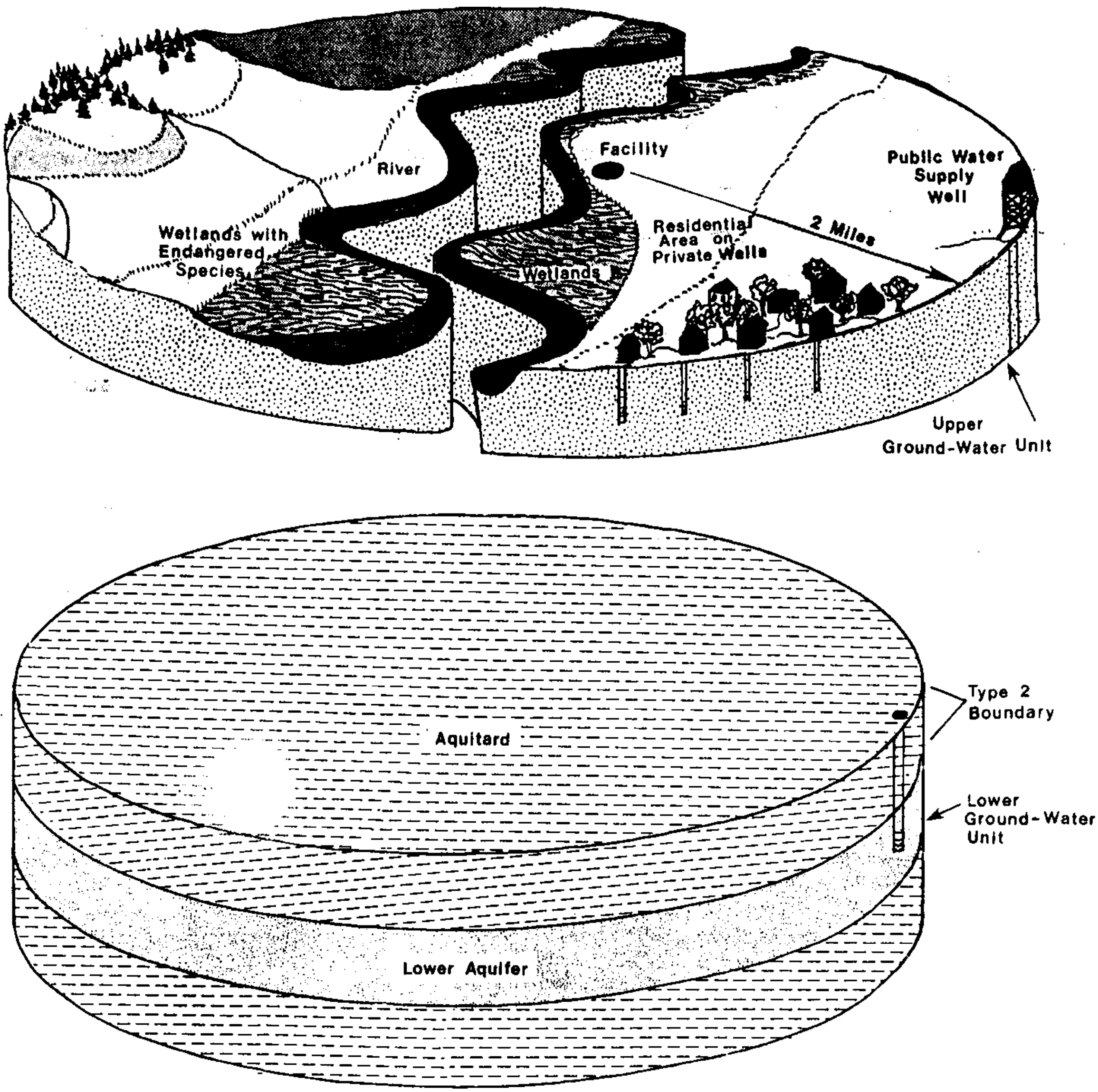


FIGURE 3-6
ILLUSTRATION OF A SUBDIVIDED CLASSIFICATION REVIEW AREA



arated by a thick, laterally extensive aquitard, as shown in the cross-section in Figure 3-5. If the aquitard is shown to satisfy all the criteria for a Type 2 boundary, then the Classification Review Area can be subdivided into two ground-water units as depicted in Figure 3-6. For an activity at the surface, the upper ground-water unit would be the most relevant to the classification decision. The lower ground-water unit would not be considered relevant and could be excluded from subsequent consideration in the classification process.

3.4 Key Terms and Concepts for Defining Class I

As mentioned previously, Class I encompasses those ground waters found to be highly vulnerable to contamination and defined as either an irreplaceable source of drinking water or as ecologically vital ground water. This section presents an expanded discussion for these, as well as supporting key terms and concepts.

3.4.1 Highly-Vulnerable Ground Water

Ground water which is highly vulnerable to contamination is characterized by a relatively high potential for contaminants to enter and/or to be transported within the flow system. This concept for classification purposes, focuses on the inherent hydrogeological characteristics of the Classification Review Area. Thus, vulnerability encompasses the leaching potential of the soil and/or vadose zone and the ability of the saturated flow system to move contaminants over a large geographic area (not just beneath any given site).

It should be noted that the Agency is providing two options for operationally defining vulnerability. Comments on these, as well as other approaches for assessing vulnerability, will be considered by the Agency in determining how best to incorporate this factor in classification decisions. Both approaches recognize that ground-water vulnerability occurs in a continuum from very low to very high vulnerability, just as soil leaching potential varies and saturated flow velocities vary from very low to very high. Advantages and disadvantages inherent in each option are provided.

Option A focuses on the use of the DRASTIC system (Aller et al, 1985), a numerical ranking system developed by the National Water Well Association, under contract to EPA. The DRASTIC method examines seven hydrogeologic characteristics of an area:

D - Depth to water table
R - net Recharge
A - Aquifer media
S - Soil media
T - Topography
I - Impact of the vadose zone
C - hydraulic Conductivity of the subject ground-water flow system

The DRASTIC method can be performed using readily available information on each of the above-listed characteristics. In most cases, for the purposes of classification, no new field work, drilling, or extensive mapping procedures should be required. The method yields a single numerical value, referred to as the DRASTIC index.

A two-tier DRASTIC criteria is proposed within Option A. The tiers are distinguished according to hydrologic regions. In regions where estimated annual potential evapotranspiration exceeds mean annual precipitation, the DRASTIC criterion for highly vulnerable is 120. This is done to incorporate some regional specificity based on this important parameter. In regions where estimated annual potential evapotranspiration does not exceed mean annual precipitation, the DRASTIC criterion for highly vulnerable is 150. Procedures for using DRASTIC in the context of a classification exercise are provided in Part II Section 4.5.

The use of DRASTIC, furthermore, is commensurate with the idea that ground-water vulnerability (for classification purposes) should not vary according to the type of activity which is being evaluated. Vulnerability to contamination must, for the purposes of a universal classification, be independent of activity type. Otherwise, the class of ground waters may change with each activity; an approach which is inconsistent with state efforts, for example. Finally, the determination of vulnerability should not be inferred as a prediction of contaminant concentrations due to facility failure, or other contaminant release from the activity under consideration.

Among the various methods considered, DRASTIC has several advantages. It was prepared using a Delphi approach (a consensus building approach) on a panel of practicing, professional hydrogeologists familiar with the potential for ground-water contamination across the nation. It builds on earlier systems, such as those of the Le Grand System (LeGrand, 1980) and the Surface Impoundment Assessment System (Silka and Sweringer, 1978). It is applicable on a regional level (i.e., several square miles), on par with the size of the Classification Review Area. Furthermore, DRASTIC was designed to be used with readily available, regional hydrogeologic information. And it was also designed to overcome the problems of more simplistic methods (e.g., single-criterion or multiple-independent-criterion system) that may ignore relevant factors or the relative importance of a factor compared to other factors (see Appendix B for discussion of other approaches considered). Yet, it is relatively simple to use and includes the primary factors inherent to the area-wide vulnerability concept implied in classification decisions.

A distinct disadvantage of requiring the use of Option A is that it denies the user of the Guidelines the opportunity to consider other methods or to exercise full freedom of professional judgment where appropriate. In addition, some believe that the DRASTIC method may oversimplify the characterization of an area where the hydrogeology is very complex.

Under Option B, users of the Guidelines could, if they wish, consider the same parameters that are considered under the DRASTIC approach, but would not be compelled to use the DRASTIC system or the numerical cutoffs set forth in these Guidelines for determining what ground waters are "highly vulnerable." Rather, those classifying the ground water would take the various parameters into account in arriving at a professional judgment of whether the ground water is "highly vulnerable." The advantage of this approach is that it provides the person classifying the ground water with complete flexibility in considering the complexity of the particular site being evaluated. The disadvantage of this approach is that, since different though well-qualified professionals may reach different judgments under the same set of circumstances, some certainty, predictability, and reproducibility is sacrificed.

3.4.2 Irreplaceable Source of Drinking Water

A ground-water source may be classified as irreplaceable if it serves a substantial population, and, if reliable delivery of comparable quality and quantity of water from alternative sources in the region would be economically infeasible or precluded by institutional constraints. It is important to emphasize that the irreplaceability criterion is a relative test in that its goal is to identify those ground waters of relatively high value (compared to others). As a result, these may deserve to be treated as unique or "special." In order to consider a source of ground water to be irreplaceable, several factors must be addressed in more detail. "Substantial population" must be considered for all assessments. Where a substantial population is determined to be present, other factors must be assessed including:

- uncommon pipeline distance
- comparable quality
- comparable quantity
- institutional constraints,
- economic infeasibility

In these draft Guidelines, the Agency is soliciting comment on approaches to judging the "replaceability" of current drinking water sources. Two options are presented to help frame the discussion. Option A would require, among other factors, a quantitative or semi-quantitative assessment of the population served by the source and the economic feasibility of replacing the source. Option B incorporates a qualitative assessment of the substantial population/economically irreplaceable factors. Under this approach, the size of the population served and the cost of using alternative sources would be evaluated, but not with the use of preferred methodologies accompanied by numerical cutoffs or other set criteria.

This section describes the factors that must be considered under either of the above alernatives and how they would be used in making a determination of "irreplaceability" under each alternative. Since Option A relies on specific techniques/cut-offs, it is discussed at greater length. Section 4.3 in Part II presents a more detailed description of methodologies, in particular for Option A, with additional background material being provided in the Appendices.

3.4.2.1 Substantial Population

Under Option A, the "substantial population" criterion can be met if at least 2500 people are served by:

- well(s) on a public system (where the people live either inside or outside the Classification Review Area), and/or

- private wells in a densely settled area (>1000 persons/sq mi).

Characteristics of U.S. public water-supply systems predominantly using ground water are described in the Federal Reporting Data System (FRDS). The system was developed by the U.S. EPA Office of Drinking Water to provide data on the size, characteristics, and compliance of public water systems. FRDS data shows that 10 percent of water-supply systems serve more than 2500 people. Thus, it generally defines areas of potentially high communal risk. That 10 percent, however, accounts for about 80 percent of the total U.S. population served by ground water. A more detailed discussion of the size of water-supply systems can be found in Appendix E.

Under Option B the relative size of the population served by the drinking water source would be one factor to consider in determining whether a source is "replaceable." The size of the population served, for example, will have to be taken into account in determining the economic feasibility of using alternative sources in the area. Thus, rather than using a formula and specific cutoff as would be required if the first approach were chosen, the user of the Guidelines would have the flexibility to balance various factors in determining whether a drinking water source is "irreplaceable."

3.4.2.2 Uncommon Pipeline Distance

Uncommon pipeline distance means a reasonable maximum distance over which water is piped in the region by populations of approximately the same size as the substantial population under consideration in the classification decision. The concept of uncommon pipeline distance was included in the irreplaceability criterion to make the classification process easier to implement. This criterion, although fairly general in nature, provides a means for estimating the limits of the area within which potential alternative water sources may be located. Without such a boundary, any water source in the country might be considered a replacement for any other water source, making the irreplaceability concept unworkable. This criterion is applicable under both Options A and B. A table presenting "uncommon pipeline distances" based on analyses of several water-supply systems is presented in Table 4-3. In all cases, this table merely provides general guidance and should be taken qualitatively.

3.4.2.3 Comparable Quality

The Agency has defined "comparable quality" in terms of the quality of raw sources of drinking water used in the area, considering, in a general way, both the types of contaminants that are present and their relative concentrations. The intent is to make rough order-of-magnitude comparisons to determine whether the potential alternative is of the same general quality as the source, and as other water used for drinking in the EPA Region, without conducting a specific, parameter-by-parameter comparison. This criterion is considered in the same manner in both Options A and B.

3.4.2.4 Comparable Quantity

The Agency intends "comparable quantity" to mean that the alternative source or sources, whether surface or ground water, is/are capable of reliably supplying water in quantities sufficient to meet the year-round needs of the population served by the ground water. This definition considers only the needs of the population at the time of the classification decision. In developing their own classification systems, states may choose, however, to consider modest population growth and increasing water needs over time. Again, this criterion would be considered in a similar manner under both Options A and B.

3.4.2.5 Institutional Constraints

For purposes of the classification system, the Agency defines institutional constraints as legal or administrative restrictions that preclude replacement water delivery and may not be alleviated through administrative procedures or market transactions. Institutional constraints can eliminate one or more possible alternative sources from consideration (and, likewise, indicate which alternate supplies are more viable than others) and, therefore, can necessitate a Class I irreplaceable designation. Such constraints limit access to alternative water sources and may involve legal, administrative, or other controls over water use.

EPA has placed potential institutional constraints into three categories:

(1) Probably Binding constraints -- which include treaties, agreements among states, and decisions by the U.S. Supreme Court that are not capable of being revised through market transactions or simple administrative processes

(2) Constraints which may possibly be binding -- such as, when market transactions, or simple administrative processes may not be able to provide an alternative source of water (e.g., limits on the source or amount of water that are created by state law)

(3) Constraints unlikely to be binding -- when market transactions, or simple administrative processes, usually can ensure an alternative source of water.

These factors would be evaluated in a similar way in both Options A and B.

3.4.2.6 Economic Infeasibility

To frame the Agency's consideration of "replaceability" for classification purposes, two options are specifically presented for public comment. In Option A, an alternative source of replacement water is economically infeasible if the annual cost to a typical user would exceed 0.7 to 1.0 percent of the mean household income in the area. EPA is proposing a threshold in this range and is seeking comment on the applicability of this economic test and/or other thresholds. Appendix G provides a detailed discussion of these tests.

Although the economic infeasibility criterion suggests an "ability to pay" measure, this does not mean that users of the water would be expected to pay for a replacement source in the highly unlikely event of contamination. Rather, this approach is intended solely as a relative test to identify those waters deserving of special protection.

This criterion does not require a rigorous analysis, but rather a general understanding of the alternative source(s) and rough estimates of replacement costs. To perform this analysis, data in the following areas are needed:

- Physical characteristics of the alternative water sources
- Estimates of capital and operating costs for using the alternative source
- Household incomes of the ground-water users.

In most instances, generally available data will be sufficient to apply this test. Simple, inexpensive estimation techniques will be adequate.

In Option B, the cost of replacing a drinking water source would be one factor in judging its "replaceability." This cost could be taken into account along with the community's ability and/or willingness to pay for alternative water sources in judging whether it is truly economically infeasible to replace the water. Recommended methods, approaches, or criteria would not be incorporated by guidance. Best professional judgement in specific situations would be the basis for decisions. To cite one example, water suppliers in some cases may be "financially constrained" in their ability to provide alternative water. These limitations could be addressed in a qualitative manner.

3.4.3 Ecologically Vital Ground Water

As a result of the guidelines development process, ecologically vital ground water (Figure 3-7) is defined as supplying a sensitive ecological system supporting a unique habitat.

Underlined in the above statement are the two terms which require further definition. A sensitive ecological system is interpreted in these guidelines as an aquatic or terrestrial ecosystem located in a ground-water discharge area. A unique habitat is primarily defined as a habitat for a listed or proposed endangered or threatened species, as designated pursuant to the Endangered Species Act (as amended in 1982). In some cases, certain Federal land management areas, congressionally designated and managed for the purpose of ecological protection, may also be considered unique habitats for ground-water protection, regardless of the presence of endangered or threatened species per se. Among those most likely to be included are:

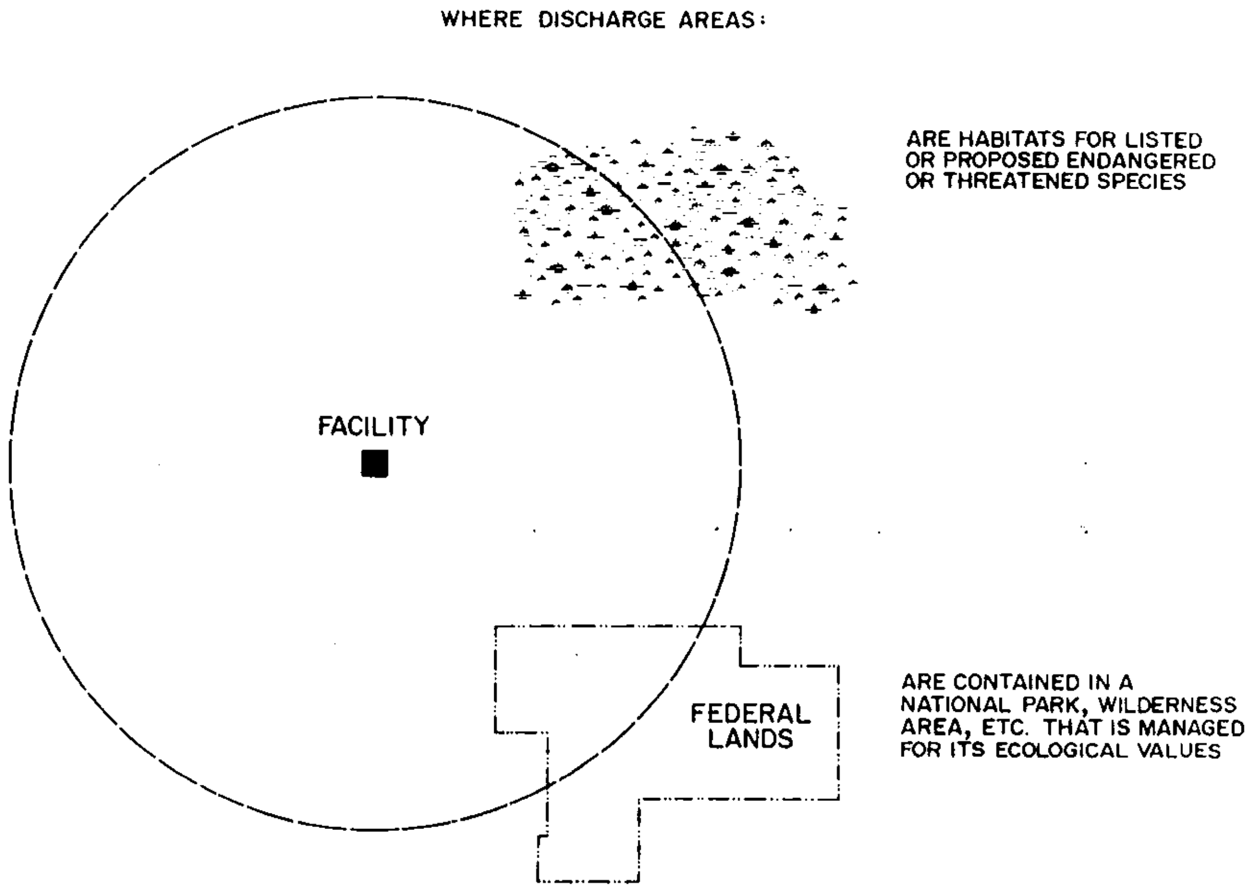
- Portions of National Parks
- National Wilderness Areas
- National Wildlife Refuges
- National Research Natural Areas.

A discharge area is an area of land beneath which there is a net annual transfer of water from the saturated zone to a surface water body, the land surface, or the root zone. The net discharge is physically manifested by an increase of hydraulic heads with depth (i.e., upward ground-water flow). These zones may be associated with natural areas of discharge, such as seeps, springs, caves, wetlands, streams, bays, or playas.

3.5 Key Terms and Concepts for Defining Class II

Class II encompasses all non-Class I ground water currently used, or potentially available, for drinking and other beneficial uses, whether or not it is particularly vulnerable to contamination. Class II has been subdivided into two subclasses which comprise the major key terms: current source of drinking water and potential source of drinking water.

FIGURE 3-7
EXAMPLE CLASS I - ECOLOGICALLY VITAL GROUND WATER



3.5.1 Current Source of Drinking Water

Ground water is considered a current source of drinking water under two conditions (Figure 3-8). The first and most common condition is the presence of one or more operating drinking-water wells (or springs) within the Classification Review Area. The second condition occurs in the absence of wells or springs, and includes ground-water discharge to a surface water reservoir used as a drinking-water supply. It requires the presence within the Classification Review Area of a water-supply watershed reservoir (or portion of a water-supply reservoir watershed) designated for water- quality protection, by either State or local government.

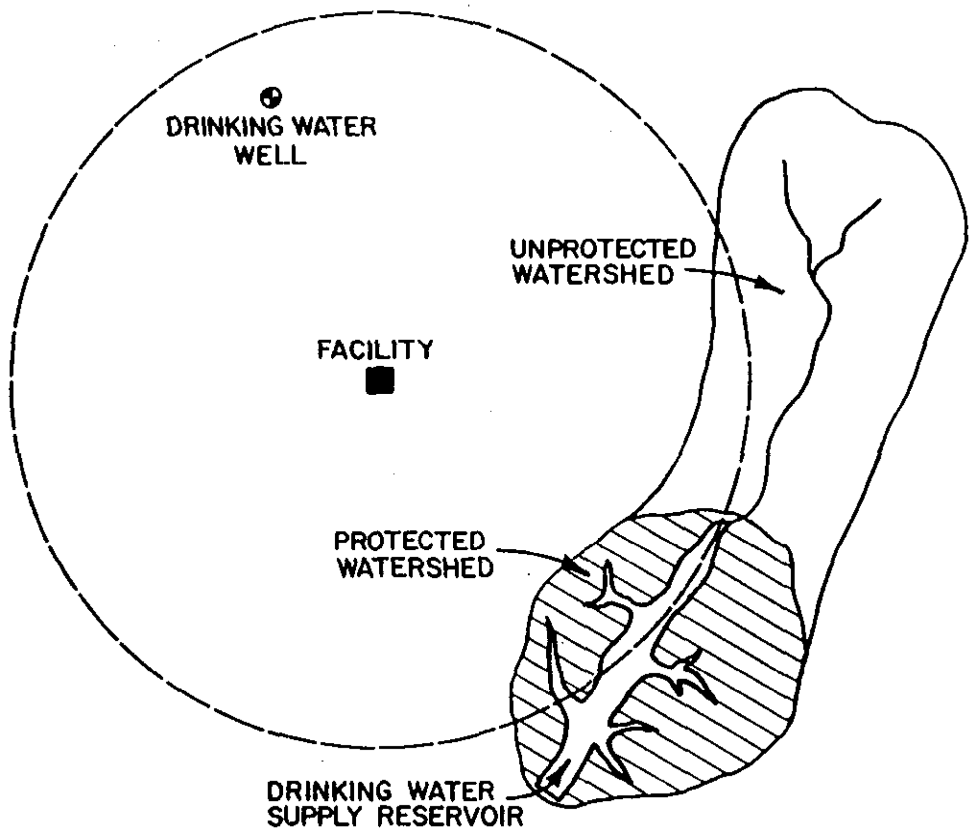
The concept of a current source of drinking water is rather broad by intent. Only a portion of the ground water in the Classification Review Area needs to be supplying water to drinking-water wells. It should also be noted that a current source of drinking water, which meets the irreplaceable/ highly vulnerable criteria, is Class I.

3.5.2 Potential Source of Drinking Water

A potential source of drinking water in the Classification Review Area is one which is capable of yielding a quantity of drinking water to a well or spring sufficient for the needs of an average family. Drinking water is taken specifically as water with a total-dissolved-solids (TDS) concentration of less than 10,000 mg/l, which can be used without treatment, or which can be treated using methods reasonably employed in a public water-supply system. The sufficient yield criterion has been established at 150 gallons/day (see Section 3.6.2 for the rationale). Ground water not currently used for a source of drinking water will be classified as a potential source of drinking water, unless demonstrated otherwise.

An uppermost limit of 10,000 mg/l TDS was chosen for several reasons. Many State and Federal programs currently use 10,000 mg/l TDS to distinguish potable from non-potable water. Some states set lower limits because the TDS of drinking water is usually well below 10,000 mg/l. A survey of rural water supplies (EPA, 1984), for which ground water was the principal source, found a maximum TDS level of 5949 mg/l. Eighty-five percent of rural water-supply systems were less than 500 mg/l TDS. Given the range of TDS values, 10,000 mg/l provides the flexibility needed in a nationwide program. It also ensures that other beneficial uses of ground water will receive substantial protection.

FIGURE 3-8
EXAMPLE CLASS II - CURRENT SOURCE OF DRINKING WATER



Establishing a minimal yield (i.e., to wells and springs) in the definition of potential source is consistent with the hierarchy of resource values reflected in the classification scheme. Areas where all water-bearing materials fail the "sufficient-yield" criterion will have little, if any, resource value for drinking water and, therefore, fall into Subclass IIIA.

By a de facto assumption, any ground water not a current source of drinking water will be classified as a potential source of drinking water, unless a lower resource value is demonstrated. This approach was chosen because it enables EPA to set a minimum Federal "floor" which provides broad protection while placing the burden of proof on the person(s) interested in demonstrating that the subject ground water meets the criteria for a lower class of ground water. Figure 3-9 indicates the concept of a potential source of drinking water.

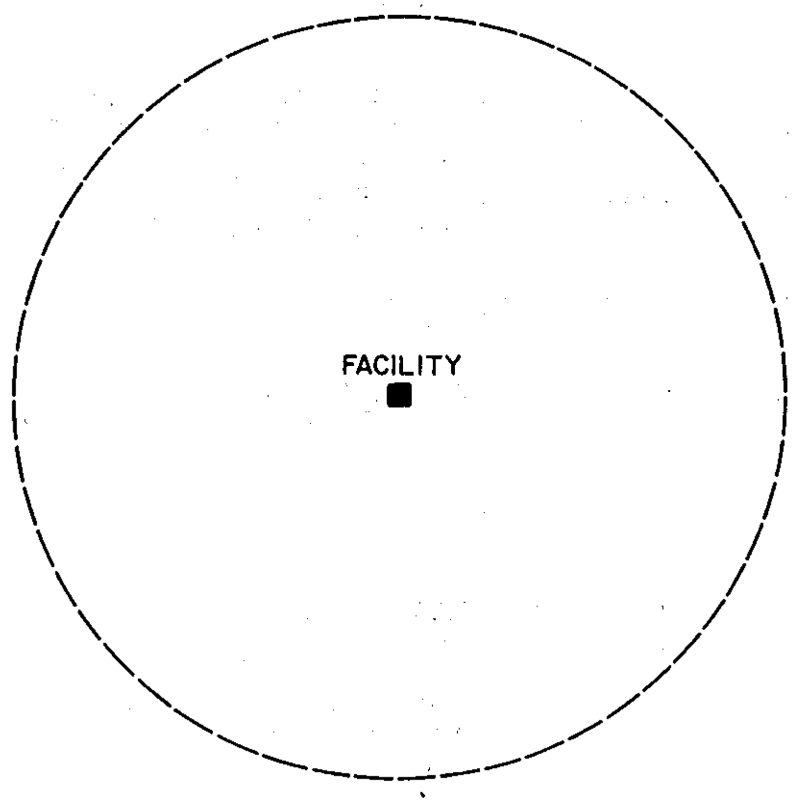
3.5.2.1 Water Quality/Yield Data Needs

Specific data needs for water-quality testing and water-yield testing were not established as part of the Class II criteria. The general rule is to presume, in the absence of data, that the quality and yield of a ground-water resource is sufficient to meet the criteria for a potential source of drinking water. Where the ground water can be demonstrated to fail the quality or yield criteria, the result could be a Class III designation.

3.5.3 Sufficient Yield

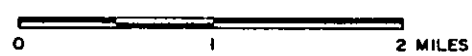
The definition of a potential source of drinking water implies a yield sufficient to meet the long-term basic needs of an average family by a well or spring. The sufficient yield criterion was established at 150 gallons-per-day (see Section 3.6.2 for rationale). In cases where the Classification Review Area or the appropriate subdivision of the Classification Review Area does not contain a well or spring routinely used for drinking water, and can be shown to have insufficient yield, then a designation of Subclass IIIA, for the ground waters in the Classification Review Area or its subdivisions (as described in Section 3.6.2), is possible. As mentioned previously, unless it is demonstrated otherwise, the Classification Review Area is presumed to meet the sufficient yield criterion.

FIGURE 3-9
EXAMPLE CLASS II - POTENTIAL SOURCE OF DRINKING WATER



NO DRINKING WATER WELLS IN CLASSIFICATION REVIEW AREA, BUT:

- <10,000 MG/L TDS
- TREATABLE IF CONTAMINATED
- CAPABLE OF YIELDING WATER TO WELL OR SPRING



3.6 Key Terms and Concepts for Defining Class III

The third class of ground water encompasses those waters which are not potential sources of drinking water due to:

1) salinity (i.e., greater than 10,000 mg/l total dissolved solids),

2) contamination, either by natural processes or by human activity (unrelated to a specific polution incident), that cannot be cleaned up using treatment methods reasonably employed in public water-supply systems (or economically treated), or

3) insufficient yield at any depth to provide for the needs of any average-size household.

Subclasses are differentiated based primarily on the degree of interconnection to adjacent waters (i.e., surface waters and/or ground water of a higher class).

The key terms and concepts underlined above are defined in this section.

3.6.1 Methods Reasonably Employed in Public Water Treatment Systems

Ground water may be considered "untreatable" if, in order to meet primary drinking water standards and other relevant Federal criteria or guidelines, treatment techniques not included on a reference list of commonly applied technologies must be used. The focus on public-water system techniques (rather than all technologies) was established in the Ground Water Protection Strategy. The reference list has been designed to account for variations in the use, availability, and applicability of treatment technologies in an EPA Region. This approach is a relatively simple decision framework that does not involve detailed engineering or cost analyses. An optional approach which focuses on treatment costs compared with total system costs is presented for review and comment in Appendix G.

For application to the classification system, EPA has made an inventory of all known or potential water- treatment technologies and classified each as belonging to one of three categories:

- Methods in common use that should be considered treatment methods reasonably employed in public water-treatment systems,

- Methods known to be in use in a limited number of cases that may, in some regions because of special circumstances, be considered reasonably employed in public water-treatment systems, and

- Methods not in use by public water-treatment systems.

Methods in common use include aeration, air stripping, carbon adsorption, chemical precipitation, chlorination, flotation, fluoridation, and granular media filtration.

Methods known to be used under special circumstances include: desalination (e.g., reverse osmosis, ultrafiltration, and electrodialysis), ion exchange, and ozonation. In most EPA Regions, these treatment methods should not be considered methods reasonably employed by public water systems. In certain EPA Regions, because of special groundwater quality or water scarcity circumstances, they may be considered reasonably employed.

Treatment methods not in use by public water treatment systems include: distillation and wet air oxidation. These methods are considered new to water treatment although they have been applied for industrial purposes in the past. Since their application to water treatment is experimental at this time, they should not be considered treatment methods reasonably employed in public water systems.

It should be stressed that some techniques such as granular media filtration are used by public water- treatment plants for polishing (e.g., final treatment). These techniques may be insufficient to adequately treat for heavily contaminated ground water. In such cases, where unrelated to a given source of pollution, a Class III designation is likely. In other cases where the listed treatment techniques are in use and would be equally effective and insignificantly more costly to apply to the contaminant under consideration, the water would be considered "reasonably treatable" and not Class III.

Treatment capacity to handle certain concentrations or combinations of contaminants may not be employed in a region, although the basic technologies are available. In these cases, the optional economics-based tests may be preferential to the reference technology approach.

3.6.2 Insufficient Yield at Any Depth

In order to establish Subclass IIIA on the basis of insufficient yield, two conditions must be met within the

Classification Review Area or appropriate subdivision of the Classification Review Area. These conditions are:

(1) There are no wells or springs used as a source of drinking water regardless of well yield.

(2) All water-bearing units meet the insufficient yield criterion.

Given variability in regional aquifer characteristics and climate, a value of 150 gallons-per-day was selected as the cutoff for sufficiency. This level of production should be possible throughout the year, in order to qualify as a potential source of drinking water. The yield can be obtainable from drilled wells, dug wells, or any other method. Agricultural, industrial, or municipal uses of these marginal water-bearing areas would require significantly higher yields than a domestic well and would, therefore, be unable to use this low-yield ground water as a water source. The figure is based on a conservatively low yield below which it is considered unlikely or impractical to support basic household needs.

In setting the sufficient yield criterion, EPA consulted its own guidelines concerning water needs and related waste flows for single family dwellings. EPA's water-supply guidelines indicate that per capita residential water needs range from 50 to 75 gallons-per-day (EPA, 1975) for a single family residence. Waste flows from single family dwellings using septic systems average 45 gallons-per-day per capita (EPA, 1980, page 51). Using an average family size and a per capita water need of approximately 50 gallons-per-day, the well-supply criterion was established at approximately 150 gallons-per-day. (Note that, to be on the conservative side, this assumption of household usage is the lowest figure used in these guidelines.)

3.6.3 Interconnection as a Class III Criterion

The subclasses of Class III ground water are differentiated in part by the relative degree of interconnection between these waters and those in adjacent ground-water units and/or surface waters. A discussion of ground-water units and the concept of degrees of interconnection is provided in Section 3.3. Subclass IIIA ground-water units are defined to have a high-to- intermediate degree of interconnection to adjacent ground-water units or surface waters. Subclass IIIB ground-water units are defined to have a low degree of interconnection to ground-water units of a higher class or surface waters within the Classification Review Area.